

ISSUES IN VIDEO EXHIBIT DESIGN: CASE STUDIES
FROM THE NATIONAL MUSEUM
OF NATURAL HISTORY

by

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DEDICATION

For the Love of Science

“At the heart of science is an essential balance between two seemingly contradictory attitudes — an openness to new ideas, no matter how bizarre or counterintuitive they may be, and the most ruthless skeptical scrutiny of all ideas, old and new. This is how deep truths are winnowed from deep nonsense” (Carl Sagan, *The Demon-Haunted World: Science as a Candle in the Dark*).

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ABSTRACT

To broaden their public outreach and advance their educational mission, museums are increasingly using videography within exhibits.

Integrating new media into collections-based encyclopedic institutions like the National Museum of Natural History presents challenges to exhibit designers, filmmakers, and curators.

Museum visitor studies address the related issue of visitor satisfaction and have become useful to assess specific techniques to bridge the gap between the public popularity and museum aims.

The Smithsonian Institution has pioneered a theoretical framework to look at visitor experience preferences, now formalized into IPOP (*Ideas, People, Objects, and Physical*). IPOP argues that people naturally find one of these categories most appealing. Studies have shown that designing exhibits and video content within the IPOP framework will, in fact, increase visitor satisfaction and overall public education.

This paper assesses the use of videography within three major National Museum of Natural History exhibits. At present, there is no unifying style or over-arching theoretical approach to the many video exhibits at the NMNH. I examine the relationship of these three films to the IPOP framework. I created my thesis film, *Tree Thinking*, to addresses IPOP categories that are presently underrepresented in the National Museum of Natural History.

INTRODUCTION

In considering the place of natural history and scientific filmmaking in our society and how film affects mass culture, the recent airing of *Cosmos: A Space Time Odyssey* provides a very encouraging example. It was by far the most popular science series in 2014. In fact, it was the most popular show ever aired by National Geographic (Kissell 2014). Even though science is under ideological assault in popular culture (Hopkins 2014), some 8.5 million people viewed the premiere and millions returned for all the segments.

The success of *Cosmos* not only serves to broaden the audience for science, but in the way the producers selected elements with wide appeal, it can point the way forward as a general model for science exhibits within museums. The series appealed to those who love large concepts: the study of space or the history of science or the epistemology of scientific knowledge. It connected with those who respond to the social side of science, showing the enthusiasm of people engaging in learning, featuring both the stories of scientists who advanced our knowledge, as well as popularizers of science such as Carl Sagan and Neil DeGrasse Tyson. It used computer-aided graphics to portray objects like the moons of Jupiter and black holes, and advanced microscopes to view the eye and explain its awe-inspiring evolution.

The reception of *Cosmos: A Space Time Odyssey* suggests that science museums are relevant and on the right track when they use film to in engage the imaginations and interests of broad groups of people. Both natural history and science museums are using an increasing number of videos in multiple formats: as featured objects within exhibits, supplementary enhancements to other featured objects, theater attractions, and online reference material (Griffiths 2003). The enthusiastic response to *Cosmos* illustrates that a significant section of Americans can embrace a highly technical science documentary. Moreover, from the standpoint of museum exhibit design, *Cosmos*'s thematic approach involving ideas, people and objects also confirms a theory of experience preference that the Smithsonian Institution has developed. The Smithsonian model accesses and predicts how visitors experience educational material and what they remember. It is known as IPOP, which stands for *Ideas, People, Objects, and Physical* interaction (although the Physical interaction was added after the original framework was developed).

This paper looks at how science videos are used at the National Museum of Natural History (NMNH) in Washington, DC, where I have spent over two years developing video content across several platforms. It assesses the aims and challenges of science museums and how videos can take forward an institution's mission. The paper uses the IPOP model to assess video installations, with case studies of three major exhibits at the NMNH. I show how these considerations shaped my film *Tree Thinking* and discuss the film's relationship to the overall mission of the NMNH. I conclude with several recommendations to maximize visitor satisfaction with video exhibit design in science museums.

CHANGING AIMS AND METHODS OF SCIENCE MUSEUMS

Museum Generations

We are living through a transitional time for science and natural history museums. While natural history museums are largely considered the “dinosaurs” of the museum industry, they are also renowned for their educational value and extensive collections (Krishtalka and Humphrey 2000). Traditional natural history museums are making it a priority to integrate new media alongside the traditional variety of stuffed animals, jarred specimens, pictures, and text.

Museums have always reflected both the present and the past. It is notable that major shifts in the roles of museums have corresponded with political and social shifts. Friedman (2010) describes three generations in the development of the museum. The first museums came from the private collections of artifacts and paintings owned by the wealthy, later turned over to a public agency for care and display.

The French Revolution and the Enlightenment introduced the egalitarian notion of civic institutions and paved the way to an encyclopedic approach to the newly formed public museums. Museums assumed the task of bringing culture to the public. Private collections of art were turned into art museums and the assemblage of historically significant furniture donations became history museums. During the early 19th century, technology collections were created to meet the practical need of industry and universities. Among these early museums were the Conservatoire National des Arts et Métiers in Paris and the Franklin Institute in Philadelphia. Their main purpose was technical training.

At the beginning of the 20th century, a second generation of technical museums began to merge museums with industrial expositions. The idea was to unite advertising and public education. The Chicago Museum of Science and Industry was established in this period. It featured the first rudimentary visitor interaction: cranks and buttons. An element of public education was added, alongside preservation and collection. However, industry dominated the technical museum era, a phenomenon which lasted up until the 1960s and 1970s. During this time, businesses actually built and branded exhibits for advertising purposes.

The Palais de la Découverte in Paris inaugurated the third generation, science museums in 1937. But science museums did not become popular until the Cold War-fueled space race. At that point, the United States made science education one of the country's top priorities. The National Science Foundation was created, the President's Science Advisory Commission began work, and funding was allocated for the Stanford Linear Accelerator Center and many other institutions (Wang 1995). This generation of museums, known as science-technology centers, put public education at the center of their mission. They rarely contained permanent collections and were dominated by interactive elements. The Exploratorium in San Francisco (founded in 1969) is considered the purest model of this type (Friedman 2010).

With the dawning of the 21st century, science museums became the fastest growing museum type (Koster 1999).

The Smithsonian's National Museum of Natural History (NMNH) falls in between the second and third generation of science museums according to Friedman's definition. Their collections are the most encyclopedic of any natural history museum in the world, with 127 million biological, mineral, and cultural objects. Research is one of the institution's highest priorities. At the same time, the NMNH devotes a significant portion of its resources to education and public outreach. The nonpublic collections side of the museum remains in the second generation because its collections are research-centric. The exhibits side is becoming the third generation, as it focuses on public outreach.

Arising from the traditions of Enlightenment thought, museums aim to raise the educational and cultural level of the citizenry. While the second and third generations, however, approach this mandate in somewhat different ways, they nevertheless both recognize the gap between the scientific world (Hopkins 2014, Peters 2013) and the general public and make it a core mission to help bridge it.

Museum organizations such as the Smithsonian Institution hold encyclopedia collections for the benefit of scientists and the country. They are also a repository of cultures by collecting and displaying what is considered important (Koster 1999). This is profoundly true for the Smithsonian, which the US government established as a public trust and is the world's largest museum and research complex. The NMNH collection has been coined the "Nation's Attic" (Appetiti 2009).

A generational shift from “being about something [the collections] to being for somebody [serving the public],” as Weil states, hinges on an important partnership between visitors and the museum (Weil 28, Kotler and Kotler 2010) and places specific demands on the museum. Such an extensive museum is responsible for enabling the public to access and understand its collections. Video archives, online databases, and resources such as lectures help bring the significance of collections to educators and the general public.

Challenges

Because NMNH is between the second and third generations of science museums, it has a dual mission. World famous for its research centers and interdisciplinary research projects, the Smithsonian sponsors the work of over 1,000 scientists and publicizes it through many websites, journals, and its magazine. Alongside these efforts, the organization has developed multi-channel educational activities to create scientific literacy throughout society. The ambitious scope of this evolving public mission imposes complex challenges: it must provide educational services for diverse segments of the population, spur active learning by its patrons and compete with “edutainment” for public support.

The NMNH has developed many informal educational methods, including traditional and interactive exhibits, presentations, demonstrations, classes, on-site programs, lesson-plans, web-based activities and films, and websites. Video now plays a major and growing role in this effort. The typical museumgoer would be surprised at the extent of the use of new media. Every major exhibit is linked to complementary videos on the exhibit’s website, YouTube and iTunesU. iTunesU is a section of Apple’s iTunes store that hosts educational videos and audio submitted by educational institutions. Additionally, the museum produces videos about its collections, on-site lectures and seminars. iTunesU currently hosts 280 videos about NMNH exhibits and lectures, with YouTube offering an additional 218 selections.

The video exhibit designer faces multifaceted challenges in such a diverse museum setting. The designer must reach different audiences and understand contemporary tastes while fulfilling the historical missions of the museum and avoiding well-known pitfalls. In short, exhibit designers and curators must achieve their educational mission and maintain popularity with the public.

To meet its educational mandate, the museum must provide up-to-date and interesting content to assist professional educators — a critical and influential audience. It must convince teachers and school administrators of the pedagogic value of field trips and other forms of museum interaction, both online and in person. The NMNH incorporates National Science Education Standards content in educational programming, making the museum a valuable and reliable resource for educators.

Studies confirm that school field trips have “lasting impacts on students with strong memories of both cognitive and sociocultural contexts” and that students “benefit most when they can connect to ideas recently covered in their curriculums” (Kisiel 2005). To this end, the NMNH education center Q?rius has many hands-on activities designed to reinforce curricula for “teens and tweens.” Examples of video initiatives aligned with national science standards include “Smithsonian Science How?”, a new webcast hosting live videos from the Q?rius theater, and interviews of museum researchers for middle and high school students.

The museum, and particularly the exhibit designers, must be highly sensitive to the needs and tastes of patrons. In a museum, the patron decides what to focus on, and this “free-choice” learning presents challenges. Serrell (1997) explains that the “visitor’s experience is not made up of what the exhibition offers but rather it consists of what he or she chooses to attend to.” For a generation attuned to video games and intense stimuli, video can have an attention-grabbing effect in this environment.

On the one hand, Falk and Dierking (2010) emphasize the lasting effects of museums, science-based hobbies and walks in nature as the most effective way to increase appreciation for science and nature, suggesting that free-choice science learning accounts for a dramatic 95 percent of science knowledge. On the other, Allen (2004) cites the challenges of learning under these unrestricted, curriculum-less, stimulus-filled environments.

It is clear, nonetheless, that because people tend to meander through the museum space, exhibit designers must make the most use of each aspect of the display and not rely on a linear series of steps for visitors to understand the overall message. Here, video’s strength is its ability to spur “affective learning,” using stories and images to develop an emotional connection between the viewer and the subject.

For all museumgoers of all ages, the exhibits must strive to engage and spark curiosity. An oft-made critique of the traditional museum exhibit is that it is a very passive experience (Hirumi et al 1994). In other words, if the “voice” of the museum, in the form of its top-down narrated interpretation and selection of facts is the only model, the experience can feel like a one-way form of communication, similar to an expository documentary. The most effective exhibits maximize active learning, encourage deeper questions and challenge the visitor’s and curator’s premises. A video exhibit designer should aim to create a framework for critical thinking and choice of interpretation.

Some museums have found that the need to increase visitor numbers competes with educational goals (Griffiths 2003). This pressure, often expressed in budget numbers, can lead to an overemphasis on “entertainment science.” For example, park rangers are now asked to wrap educational messages inside “pleasurable experiences”; and even the Zagat survey publishes a family guide that rates museums alongside for-profit entertainment destinations (Weaver 2007). At present the NMNH’s most popular exhibit, dinosaurs, is temporarily unavailable and the museum is under pressure to come up with popular draws, even at the expense of its long-term mission, education. This is a danger pointed to by Weil (64). New media — when it is imaginatively incorporated into the educational theme — can be decisive in engaging a large diversity of learners.

Building a bridge between popularity and learning, even in the absence of financial concerns, is a continuing challenge. Museums are sometimes perceived as stuffy, even pretentious “graveyards for stuff or tombs for inanimate things.” (Durstun 2013). Natural history museums have been criticized for lack of information, boring displays, broken interactives, etc (Smith 2014). These opinions may appear as simple anti-intellectualism, but may in fact point to a lack of accessibility and stimulation in some museum exhibits. New media and the well-designed video exhibit can make a dramatic improvement in creating an exciting and lively learning experience.

Studies have shown that people also attend museums to be with other people, an often underrated aspect of the visitor experience (Kotler and Kotler 2010, via Hood 1983). Museumgoers tend to gravitate towards their existing interests and then enjoy sharing them with other visitors within and outside of their group.

Serrell (1997) suggests museums produce exhibits that appeal to broad interests and varying levels of understanding in order to engage the largest number of people. Further evidence suggests the visitor's experience can be "enhanced by resources that support visitors in producing experiences for others" (Lehn 2011/12). In other words, visitors want to have "object" experience, "introspective" experiences, "cognitive" experiences, and "social" experiences (Kotler and Kotler 2010, via Doering). Both the architecture of the exhibit space and the design of theater spaces can create a social experience.

In sum, the contemporary museum faces the demands of educational relevance, budget constraints, serving diverse audiences, and maintaining visitor engagement. Curators and designers should consciously approach all of these problems, and make each exhibit one that leads to visitor satisfaction.

ENHANCING VISITOR SATISFACTION WITH VIDEO

Greater use of video has become a significant and highly successful means to address the widely varying types and interests of museumgoers. Science museums today feature all combinations of theaters, IMAX, kiosks, monitors, and touch-based video displays. An exhibit's age can quickly be surmised by looking at the number of videos on display. The NMNH Hall of Bones, whose most recent facelift was the 1970s, has no video and uses very advanced language in the labels. The newer Sant Ocean Hall exhibit, on the other hand, has 19 videos, interactive animations and activities.

Museums typically use video to support the themes of exhibits and increase public appeal (Lehn 2005). Videos have an unequalled ability to transport the audience into a world they would not otherwise experience — seeing extraordinary objects, visiting new places, meeting unusual people and learning about new theories and opinions. Viewers see the movement and hear the sounds, and almost feel the atmosphere and textures of remote or inaccessible venues. Viewers can get a palpable glimpse of the joy of scientific discovery or the disappointment of failing to find a specimen from a declining species. Video offers an immersion that text, photos, or live demonstrations cannot.

At the same time, for maximum effectiveness in drawing in the population and reaching new audiences, exhibit-designers need to be wary of screen saturation. Johnson (1998) lists the important principles for websites, which apply equally to exhibits: avoid video for video's sake, make sure that users can access the video, maximize the production quality, quality over quantity, and never underestimate the element of surprise.

Moreover, as the saying goes, timing is everything. This is not a small factor in museum video selection and placement. Watching a video at a museum, especially a long one, from the start to finish is a serious time commitment (Serrell 2002). So the lengths of the videos and the average time a person spends in any one exhibit should be considered. Serrell found that videos longer than three minutes need an activity to keep visitor's attention, videos from the middle to the end of the exhibit were opportunities for people to take a break from walking and reading. The study recommended that videos, especially videos longer than three minutes, should be reserved for places outside of the flow of sound and foot traffic.

Videos on exhibit must meet the same criteria as other parts of the exhibit. They must support the message of the exhibit and the museum, be physically accessible and placed in an architecturally pleasing manner and present new information. Additionally, when museum patrons can select between video options, it is more likely that the visit will be satisfying.

THE IPOP MODEL

It is necessary to increase the video and film experiences of museumgoers. But this by itself does not increase visitor engagement. Museums must understand their audiences and attract new visitors. To find a more theoretical approach to broadening accessibility, increasing visitor satisfaction and promoting museum education, Andrew Pekarik and the Smithsonian Institution (SI) developed the IPOP experience preference model (Pekarik 2010).

As a national educational institution, with 30 million visitors in 2013 (eight million of which visited the NMNH), the SI is data-rich with visitor statistics (SI Newsdesk). The Smithsonian has conducted comprehensive visitor studies to better serve museum audiences.

Traditionally surveys or censuses divide people by age, race, income, and education level. The IPOP model, developed over the last 16 years, explains that diversity in learning experiences is explained less by demographics than by ways of thinking. The theory explains that different people are attracted to different types of experiences that they find more interesting and therefore more memorable (Pekarik 2014).

The IPOP framework is:

- *Ideas*: an attraction to concepts, abstractions, linear thought, rational reasoning, and facts
- *People*: an attraction to emotion, stories, and social interactions
- *Objects*: an attraction to things, aesthetics, craftsmanship, ownership, and visual language
- *Physical*: an attraction to physical sensations, including movement, touch, sound, lights, and smells

These typologies provide a method to understand and then raise the engagement levels of museumgoers, providing a more satisfying and educational experience. As Pekarik noted, an individual's overall orientation will determine what the individual pays attention to, how he or she chooses an exhibit or how long they interact with it, and how they assess their experience (Pekarik 2014). Moreover, since the typologies are postulated to influence behavior, they can be empirically measured.

Pekarik identified visitors' personal experience preferences through a self-administered questionnaire. Remarkably 79% of visitors showed a clear preference for one category, with 18% selecting idea, 18% people 19% object and 23% physical interaction. Studies have also shown that 21% of interviewees prefer a combination of two dimensions. Combining the outcome of these questionnaires with tracking and timing of museum patrons, Pekarik et al. have demonstrated the predictive power of the typologies. They have found that exhibits using the model have visitors engaging for longer periods of time and reporting better overall satisfaction with their museum experience. They also found that displays that have closely related and equally strong elements are most likely to result in flip experiences, and therefore increased visitor engagement and satisfaction (Pekarik, 2014).

This notion of flipping the experience is one of the most important conclusions drawn by the IPOP theorists. Pekarik et al state:

We believe that when an individual has the kind of experience that s/he is generally drawn to, that person is likely to feel a sense of satisfaction, since expectations will have been met. But when that person has an additional unexpected experience in a dimension that s/he is not generally drawn to, that experience will seem particularly meaningful and memorable. We refer to this encounter with an unexpected IPOP dimension as a 'flip' experience, and hypothesize that having flip experiences will be associated with a higher rating of overall experience in an exhibition or museum.

IPOP shares with other theories of engagement and education the conception of fitting new knowledge into a pre-existing mental framework. There are many studies describing how people learn, types of intelligences, and learning styles. Most agree that material needs to be presented in a plurality of ways. "New schemas are created every time that one fact is linked to another by a logical or semantic connection. Each schema is a sub-schema of another larger and related schema, and each schema has set of sub-schemas of its own" (Prichard 2009 p 24). By presenting material through the different typologies, IPOP-driven exhibits acts as a method to build a "schema" and help situate the information.

In 2011, Pekarik began a collaboration to examine mathematical patterns within IPOP data among visitors (Schreiber and Pekarik, 2014) and provide empirical verification of the typologies. Their view has also been corroborated by the work of Jean-François Léger of the Canadian Museum of Civilization in Ottawa. Léger (2014) also emphasizes that a "flip" can energize visitors and give them exhibition experiences that are special, significant, and memorable.

The theoretical concepts that Andrew Pekarik and his colleagues are developing have important practical implications for both the content of video within a museum context and its design within exhibits. Overall, Pekarik et al. (2014) concluded that IPOP assists exhibit-designers to appreciate how people differ, provide a framework for diverse preferences, develop flip experiences, and understand audiences deeply, that is, inform exhibit development and curation with a deeper social insight.

CASE STUDIES AT THE NMNH

The NMNH currently has approximately 74 videos on display in the permanent halls, with many more rotating through temporary exhibits, and online. Curators and exhibit producers have to answer many questions when choosing videos. Why choose a video over a physical object? The museum has a warehouse of biodiversity to choose from in the collections. What will the video accomplish that physical specimens, pictures and text cannot? How will the video be made physically accessible? Will it have seating? Will it have audio that might effect the soundscape of the exhibit? Can people of all heights view and hear it? How long should it be? In what style should it be made? Who should make it?

Videos need to be integrated seamlessly into the exhibit, adhere to the primary messages, not detract from other portions, and achieve their own purpose. At present, there is no unifying style or overarching theoretical approach to video exhibits at the NMNH.

This paper will review three current major offerings representing different eras of exhibit design: the Sant Ocean Hall (2008), the Koch Hall of Human Origins (2010), and the Hall of Bones (1964-1966). This study treats the video content for these three exhibit through the IPOP framework. The analysis will use Pekarik's definitions and the following criteria: *Ideas*: Does the video support an abstract concept and broad topic that aids the theme of the exhibit? ; *People*: Does the video feature an important person in the field that conveys a connection with the viewer? Does the video create a sense of human connection, affective experiences, have a story or social interactions?; *Objects*: Each video acts in some way as an object within the exhibit, but is it a primary object that offers new information? Is the primary function to display an organism? Does it support a different primary object? Is it a moving picture or slideshow, or does it offer a narrative worthy of watching in its entirety? Is the appeal derived from the item on the screen, its aesthetics, craftsmanship or visual language?; *Physical*: Is there physical interaction, choice of segments? The physical element is less applicable to video and was originally a classification for elements in the entirety of an exhibit.

The Sant Ocean Hall

Created in 2008, the Sant Ocean Hall emphasizes the diversity and fragility of ocean ecosystems. It is a very lively exhibit featuring 19 videos. There are two theaters: one with a traditional screen and the other projected on a sphere (Science on a Sphere NOAA). The hall has three kiosk stations with options for multiple videos. Finally, there are looping videos mounted on walls, many without audio.

The cumulative effect is visually immersive, affirming the incredible diversity of life within our ocean ecosystems. To experience the hall fully, one must look out, down, up and around, because there are impressive specimens everywhere. Sant Hall exhibits include “674 marine specimens and models, high-definition video, and the newest technology allows visitors to explore the ocean's past, present, and future” (Ocean Portal website 2014).

Evaluating the hall with the IPOP model reveals that all typologies are represented, but unequally. The exhibit's strength is its display of objects and specimens. Of the 19 screens, 5 have no audio and function as *Objects*. Two of these videos contain bioluminescent organisms, one has hydrothermal organisms (deep sea volcanoes), another features orcas, and the final video explains the evolution of whales. These videos may visually introduce visitors to new forms of life, but even if viewers already have some knowledge of these species, the video displays of ocean life with intense coloration, illumination, unique shapes and movements are highly effective. These videos lack audio and narrative but still maintain their visual appeal.

Considering the primary message of the hall is the amazing biodiversity of earth, the emphasis on the *Object* category is successful. What these silent videos lack, however, is an immersive quality that is achieved with audio and narrative. A viewer cannot make an emotional connection to a foreign object on the screen any more than the stationary object next to it. The single dimension to the audio-less videos calls into question the decision to use video. Moreover, the large numbers of videos on display require silence from some videos in order to avoid aural competition, and thereby diminish their potential impact .

The remaining *Object* videos include audio and use multiple IPOP categories. The Ocean Portal kiosks, for example, allow a selection of videos and include ecosystems, individual species, ocean news,

discoveries, science, and animals. Other kiosks offer video choice via touch. There is some overlap between the primary *Object* focus with *People* and *Ideas*, and minimal *Physical* action.

Overall, however, the *People* category is quite limited in Sant. This is especially glaring, since oceanography is a field with a large number of active researchers and considerable public interest. While there are some videos in which researchers explain the life histories of marine animals, I found only one film in which researchers talk about their actual research experiences, or relate anything but the method or findings. For someone, such as myself, who is fascinated by *People*, it feels dry and sterile to not see the researchers, feel their personalities, and understand their motivations.

The Ocean Explorer Theater loops a Smithsonian-directed short film, *Deep Ocean Explorers*, which provides the hall's one view into the work of scientists. The 13-minute film features researchers using deep-sea submersibles. It is divided into short acts that correspond to other portions of the exhibit: Surface Zone, Twilight Zone, and Deep Ocean. While the storyline is weak, it is the one *People*-oriented film within the hall. It begins with the researchers reflecting on their childhoods and how a fascination for collecting animals lives on in their careers. The scientists discuss how being in the submersible changed their outlook, and the unique life forms they witnessed. The personalities of the researchers come through, even though most of the film just lists the animals they have seen.

The more complex *Ideas* focus is reserved for the theater videos. *Science on a Sphere* features five segments: "The Blooming Earth," "An Ocean of Change," "Ocean Motion," "Air Meet Ocean," and "Changing Climate Changing Ocean." The film is designed to be viewed from all sides of the sphere that is elevated at the center of theater seating. Each segment lasts no more than six minutes and employs the spherical shape to good effect in demonstrating currents, wind patterns, and storm trajectories. The content takes full advantage of the sphere. The series is well-designed and the nontraditional projection easily draws attention and is physically inclusive. But the mode of content delivery is all facts. The educational style of the narration is very passive and does not draw the viewer in. Some examples are: "The earth was once very hot;" "Phytoplankton produce 50% of the world's oxygen;" and "If you dropped rubber ducks all over the ocean, they would float in this series of patterns on the surface of the oceans." This narration style widens the separation between science and the viewers. Moreover, the narrator asks no large questions of

the viewers, even during the longest segment about climate change. Finally, the pacing of the videos is too consistent, and it lacks tension within the segments.

In sum, while the Sant Ocean Hall exhibit incorporates the four elements of IPOP, it is not done with a balanced or conscious approach. It would be rare that a visitor could “flip” and discover an interest preference that he did not already have. Nevertheless, it is interesting to note that even though the Sant Ocean Hall was created before IPOP was formally presented, it represents an informal and organic trend towards IPOP.

The Koch Hall of Human Origins

A very popular new exhibit, the Koch Hall of Human Origins, was completed in 2010. The hall is an evidence-based exhibit with a clear message: the characteristics that make us human (large brains, using tools, walking upright, agriculture) developed during times of climate fluctuation. Its use of videos is striking and systematically underlines this central question: “What makes us human?”.

The visitor enters the hall through an unusual tunnel with animated projection video. The animation introduces the whole exhibit, and is followed by a variety of other video including 12 stations, three interactive modern dioramas, an animated graph of climate fluctuations, a small theater and several smaller movies.

Starting with the animated hallway, the hall takes the visitor on a figurative journey back in time to when the early humans roamed Africa. The videos in the modern dioramas play a central role in the narrative of the exhibit. They show archeological elements as they were found and how they are “read” by anthropologists. The dioramas share informative content in an engaging manner. The exhibit’s concluding film returns our “time travelers” to the present and explains that despite the superficial diversity among modern humans, we are all the same species.

The Koch Hall of Human Origins differs in two important ways from the Sant Ocean Hall in its use of video. Each film focuses on a different aspect of the main theme and many videos connect viewers with the museum’s researchers and their work. Unlike the Sant Ocean Hall, the Hall of Human Origins has fewer screens and a minimal number of *Object* videos. The Koch Hall uses a simple moving image without

narrative in several cases — one such video is a fire. This is an interesting choice. While simple, the animation appropriately marks the revolutionary change for humans when fire was mastered. Another *Object* videos shows primitive tool making, again a major leap in the separation of man from other animals. Examples of primitive tools accompany the video display. Visitors are able to witness both the process and outcomes from long ago. Somewhat different is the short film clip showing humans and chimpanzees making the same facial expressions, emphasizing that man is still fully part the animal kingdom.

A classic example of the *Idea* category in the Koch Hall of Human Origins is the video titled *One Species Worldwide*. This film is offered in a theater space that echoes its theme: inclusivity. Its primary message is that all humans are the same species despite superficial differences in appearance. This video's message is strengthened with its placement at the end of the exhibit.

After providing many reasons why people differ from early humans and animals, the video wraps up the exhibit reminding people that *Homo sapiens* differ at most genetically by .1%. While it is good to celebrate diversity, in fact people are more the same than they are different. The video is projected on a circle platform, and the seating consists of curved benches. There are no armrests or physical barriers between people. For each of the videos within this hall, creators made deliberate architectural choices that aid in the experience of viewing and understanding the video's content. Each video is placed so there are no other videos that might distract the viewer.

Perhaps the biggest contrast between the use of video in Sant Ocean Hall and the Koch Hall of Human Origins is in the *People* content. The latter allows visitors to make a strong personal connection with researchers through its use of interactive dioramas.

The dioramas include, in fact, all the categories of IPOP, which, studies show, is the most conducive formula for visitor satisfaction. Each station, a “snapshot of survival,” features an archeological excavation site: Swartkrans in South Africa, Olorgesailie in Kenya, and the Shanidar Cave in Iraq. As the visitors enter the different cave-like spaces, they experience an animated introduction to the site and the option of four buttons that correspond to four original *Objects* (or archaeological “clues”) as they were found at the site. The buttons trigger videos featuring a Smithsonian researcher explaining his or her work and the varying aspects of early human development. Museumgoers *Physically* select a button

corresponding to an artifact, an archeological “clue.” They can also touch a cast of the *Object*, a somatic or *Physical* interaction. The videos then connect the artifacts to the larger study of archeology and *Idea* of human evolution and the scientist involved with the study.

The dioramas within the Hall of Human Origins are, in my opinion, the most successful and unique use of video within the NMNH. Exhibitors originally designed dioramas as a way to demonstrate an animal group and its surrounding habitat (Gyllenhaal 2013). Traditional dioramas are sometimes beautiful, but to the visitors who know little about the animal, they offer little information. Donna Haraway (1984) finds the arrangements at the American Museum of Natural History distasteful for its sexist positions between males and female family groups. But more importantly, if viewers do not know what to look at, what is significant, they glean very little. So, visiting families will recognize the family in the group, and move on. The diorama never explains why the choice of animals within the landscape or how the people or animals survived. Dioramas typically displayed a conclusion through artistic representation. The Hall of Human Origins reinvents the diorama and provides a structure for visitors to learn. They still provide that feeling of immersion, but are complemented and updated with social, scientific and historical context, interactivity, and broad ideas.

These dioramas demonstrate a successful and unique integration of video into the exhibit. They are effective due to their interactive elements, the relevance and succinct nature of the videos, the inclusion of IPOP elements, and their appealing “cozy” theater ambience. The intimate space of the dioramas is very successful with young children. Despite the challenging nature of the information delivered in the video, youngsters will sit in the middle of the arched space and watch the videos unfold, apparently riveted by the experience.

Additionally these spaces highlight the research from the NMNH. The videos show audiences how the researchers think, what questions they ask and how they draw their conclusions. Not only do the videos engage the audience with the researchers’ ideas, but viewers learn a bit about the personality of the researcher. Unlike the “voice of god” style video from the Sant Ocean Hall, at the Hall of Human Origins the viewer sees the researcher as a person struggling with the challenges of scientific inquiry. This is

precisely the type of connection with the *Ideas, People, Objects* and *Physical* interaction that IPOP encourages.

This hall, like Sant Ocean Hall, did not build its videos according to the IPOP model, but nevertheless incorporated its typological elements. Of course preferences for *Objects* or *People*, etc. is not new. What is new is the formalization into a system of rating and categorization. The Hall of Human Origins marks a development in exhibit design through its use and integration of IPOP elements, anticipating the theory's enunciation.

The Hall of Bones

The Hall of Bones is the oldest hall at the National Museum of Natural History and it is the only exhibit that the Smithsonian does not plan to physically renovate. Some of the specimens in the hall were once on display in the US National Museum, which dates to before the Smithsonian became multiple museums. Its last changes were made in the 1970s. When a visitor enters the hall, it feels old: there is no media, glass cases separate the viewer from skeletons, the signs have very stylized colors and text typefaces, and the text is very complex. Besides the skeletons, the content of the exhibit is relatively inaccessible to people who have not studied the evolution of vertebrates.

For this reason, Diana Marques in conjunction with Robert Costello, program manager at the NMNH Department of Outreach and Education, have developed an iPad application, named Skin & Bones, to “digitally renovate” the hall. I have been collaborating on this project for the past year, shooting and editing a majority of the video content.

This new Skin & Bones application has even more videos than Sant Hall, a total of 32. But, more importantly, the entire visitor experience is new. The application documents 13 of the hall's skeletons, and uses each of the IPOP categories. There are content choices for each animal including: Big Idea (*Idea*), Meet the Scientist (*People*), Animal Life (*Objects*), Skeleton Works (*Physical and Big Idea*), and Activity (*Physical*). The viewer can choose where and when the videos are watched.

This augmented reality (*Physical and Idea*) is the true integration of specimens with the technology. Newly developed 3D tracking technology is digitally tethered to the specific animal's skeleton.

This allows visitors of every height, from any angle, to hold up the ipad and see a superimposed 3D model of the animal with their “skins.”

Some of the models are static; others have animations that illustrate the animal’s unique characteristics. For example, the augmented pileated woodpecker animation shows the specialized tongue and hyoid bone structure and movement. The peculiar locomotion of the vampire bat — the only bat that “runs” on the ground — is demonstrated for that skeleton. In theory, this choice should appeal to people interested in *Objects*. But in reality, it is the most popular choice in the application based on preliminary visitor responses.

For most visitors, Skin & Bones will be their first time experiencing this 3D tracking technology, which only just emerged on the market. It is expected to offer great educational opportunities (Pasaréti 2011). The augmented reality option reinforces two IPOP categories including *Ideas*, an underrepresented focus within the NMNH as a whole. The augmented reality options are *Objects*.

The application’s “Big Idea” selection (*Ideas*) is compelling. Videos portray animal characteristics or strategies that are shared by more than one species, showing broader adaptations in nature. One video, for example, shows how the rattlesnake uses venom as a defense mechanism, pointing out that it is one of hundreds of animals with this capacity. Another video discusses color signaling, another common adaptation, and highlights the mandrill, a primate whose coloration reveals its place in the social hierarchy.

The “Meet the Scientist” videos (*People*) feature both current and historical contributions to the Bone Hall. Researchers discuss how they came to be scientists and memorable experiences from the field. Helen James, an ornithologist who grew up in a family of bird scientists, describes how she digs in the lava tubes of Hawaii for fossilized birds. Spencer Fullerton Baird is honored for his tenure as Smithsonian secretary with a video showing how he sent researchers all over the world, therefore enabling him to quadruple the number of specimens in the Smithsonian’s collections.

The “Meet the Scientist” videos play several very important roles for the museum. While the NMNH is foremost a research a research facility and only second a museum for the general public, this behind-the-scenes look at Smithsonian scientists is quite unique. These videos show that the researchers are

not simply doing science, but are real people asking how the world works. As a result of the overall IPOPOP conceptualization of Skin & Bones, these video interviews were designed to elicit stories that could allow researchers' personalities to shine through. This conscious approach to the videos effectively makes the appeal to *People*-oriented visitors. This aspect of Skin & Bones also marks another step forward from those within the Sant Ocean Hall and the Koch Hall of Human Origins.

The "Animal Life" videos (*Object*) were produced along the lines of most natural history "creature features." They highlight the life history and unusual adaptations of that animal. The brown kiwi video, for example, discusses the flightless bird's diet, habitat and anatomy. These videos will appeal to the many animal lovers who visit the NMNH.

There is also a "Games" selection on the application that fulfills the *Physical* element. Visitors can attempt to recreate the tapping of a woodpecker or match the larval fish to the adult version. *Physical* elements are especially lacking at NMNH, even though research indicates their educational strengths (Zhang et al 2006).

The Skin & Bones application incorporates the lessons of many visitor studies (OP&A 2007, 2009-10) and is the first NMNH exhibit deliberately built upon the IPOPOP model. The results of the Hall of Bones' digital renovation will be tracked and measured by the NMNH. It represents the first all-media, virtual exhibit, and is without precedent in the Smithsonian.

Visitors can experience the exhibit preserved as it was since the 1970s while simultaneously using the latest technology. People can freely choose the information type they seek, and share that experience or consume it individually. By delivering video within a mobile application, the content is accessible to anyone with an Apple device and can be watched outside the museum.

TREE THINKING

My thesis film, *Tree Thinking* is designed for museum use, but is different from other museum films because it is consciously informed by IPOP. It aims to address in a balanced way *Ideas*, *People*, and *Objects*, a perspective that I learned as the cinematographer and editor of the video content for the Skin & Bones Application. This film, therefore, specifically addresses content and content-types, which are presently underrepresented in the NMNH. Its inclusion within existing biology exhibits would therefore assist in facilitating “flip” and wider visitor satisfaction.

Tree Thinking aims to highlight the museum’s research, humanize the researchers (*People*), and provide several explanations of more complicated concepts (*Ideas*), while bearing in mind the need to show specific *Object* examples of research subjects. My survey of video film in the NMNH indicated that the number of films addressing more sophisticated concepts (*Ideas*) are limited, curtailing the choices of the more educated or inquisitive visitor. For that reason, I felt the topic of the scientific method and specifically phylogenetic trees, was an important subject that should be represented in the museum.

Tree Thinking is a complex and information heavy film. The intricate principles of phylogenetics require a foundation in biological education. The film is not intended for the general audience, but for high school students that have studied upper-level biology or adults looking to supplement their knowledge. In order to understand and appreciate the film and connect with the researchers, students should be familiar with the topic at least on a basic level. This film is designed to fill a gap in museums which need more advanced content.

The People

The National Museum of Natural History — one of the nation’s preeminent science museums — presently has very few explanations of research that happens within its very own walls. For those who identify with the scientists and are curious about how they work, I wanted to give a slice of daily research

life. There are few examples within the exhibits, aside from the new Skin & Bones application, which show the personalities and stories of these devoted scientists.

I chose three diverse subjects for the film: three people with which to connect and three different perspectives on “tree thinking.”

Vicki Funk’s life’s work is classifying species and constructing mega-trees. She documents phylogeography. Her trees tell the stories of plants moving across continents over the course of millennia. This is tree making in its broadest application. She is also a senior scientist, teacher, and remains a field collector. Her lively personality and useful analogies keep her content very accessible for viewers, even if they know nothing about botany.

Ted Schultz’s work revolves around species reconstruction and he explains in a captivating manner how his phylogenetic tree “is one big story.” Ted is a renowned entomologist, continues to collect in the field, and also has experience explaining his research.

Rick Potts uses trees more tangentially in his work. Nevertheless, his research deals with the most intriguing tree of all — the “story of us,” the tree of human ancestry.

The researchers who appear in the film are trusted, reliable sources at the top of their respective fields. They present their research and questions with as little bias as possible. They speak to the relevance of *Tree Thinking* in the research world and within the NMNH. Each one is clearly passionate about bringing a scientific understanding of biological concepts to the general public. This passion about their life’s work provides an invaluable perspective to the film.

The Ideas

The IPOPOP model indicates that museums must make the effort to increase *Idea* content in order to balance with the other three areas of visitor preference. They would be well-served to increase the diversity of *Idea* topics and incorporate more such films.

Phylogeny, evolution, and the scientific method area all complex *Ideas* that are addressed in *Tree Thinking*. Trees contain complex information, are abstract in that they visualize the step-by-step of evolution, and are created through calculating mathematical probabilities.

Communicating abstract ideas is difficult by its very nature, but studies show that using a blend of analogies, explanations and stories helps people grasp the underlying ideas (Podolefsky and Finkelstein 2007). This is why IPOP is so helpful in communicating Ideas and it is the basis of my approach. In contrast to a school setting, because museumgoers are not typically tested and evaluated after a visit and they will pay attention only to what interests them. But to communicate an advanced idea in a linear progression, a film has more leeway than a static display and is an excellent medium for this IPOP category.

Phylogenetic trees are branching diagrams which illustrate inferred evolutionary relationships between species. One cannot understand the concept simply by watching *Tree Thinking*, nonetheless the film introduces elements designed to linger with the student. Using examples of phylogenetic trees does not necessarily teach that abstract concept, because the idea should be nestled in the relevance of real-world applications to provide a balance between concrete and abstract information (Felder et al 2000). Therefore, the film puts in context how researchers use trees and also animates portions of tree development to further illustrate their function.

The American Museum of Natural History drew similar conclusions regarding the challenge of addressing abstract scientific concepts within museums. After designing an Einstein exhibit in 2002 they noted (Siegel 2008):

Every abstract idea is able to be exhibited — even the immense imagining behind the Theory of Special Relativity. The trick may be to reveal the abstract as a result of human inspiration, and connect it with the visitor’s imagination.... Our approach was to attempt to describe the world through his eyes: his imagination, his passion for humanity and his curiosity about how the world works.

Tree Thinking and its interaction with three Smithsonian scientists seek to show the passions and scientific curiosity of leading figures in today’s research.

Becoming familiar with phylogenetics takes a long time and the film barely scratches the surface. But the topic is critical to the understanding of evolutionary relationships and is key to the everyday work of the hundreds of researchers at the Smithsonian. The topic also illustrates the larger message that all of science is a process – a collective process. All answers are contingent on the questions being asked, and

phylogenetic trees are the manifestation of questions. Stuart Firestein captures the spirit of the scientific method (p. 11):

Questions are more relevant than answers. Questions are bigger than answers. One good question can give rise to several layers of answers, can inspire decades-long searches for solutions, can generate whole new fields of inquiry, and can prompt changes in entrenched thinking. Answers, on the other hand, often end the process.

The *Objects*

The *Objects* or research subjects in *Tree Thinking* are yet another means of capturing the attention of the audience. The film selects three different forms of life as *Objects* — a plant and its hybrid relatives, an animal and humans.

Vicki Funk searches for two species and their possible hybrids on the shores of Oahu, Hawaii. Funk remarks on the dilemmas botanists face in describing plant species and the surprising way they differ from animals. While plants are not typically given the “hero” role in films like animals are, she notes, they possess many fascinating and unknown traits. The film aims to show a few of these characteristics and explain how phylogenetic relationships between species are determined.

Many people underrate the “lowly ant” and are unfamiliar with their complex behaviors. The outsized place in our ecosystem of the leaf-cutter ant will astonish many viewers. In this interview segment of my film, entomologist Ted Schultz shows his efforts to pinpoint specific genes within the leaf-cutters (among those that went extinct millions of years ago) and show how evolution works.

Humanity is obviously the most the familiar subject matter, but our evolution is the most contentious topic of all. This year marks the 90th anniversary of the Scopes Trial, which challenged the teaching of evolution, and teachers are still reluctant to teach evolution (Mann 2011). Rick Potts discusses why human evolution occurred, using clues that have literally arisen from the dead. He analyzes ancient earth cores, plant material, animal fossils, the ecosystem landscape, and the climate, making inferences about humans. His story uses the most *Objects*.

A Final Consideration

Filmmakers for museum exhibits can popularize their material and not feel obligated to cut scientific corners. A documentary within an exhibit should show where we stand in our quest for scientific truth at the time of its production. I have created *Tree Thinking* to meet both the expectations of visitors and the standards of the Smithsonian. The film was reviewed for accuracy by the researchers interviewed in the film as well as the Office of Education and Outreach. Museums are trusted by the general public, and have the obligation to be as factually correct as possible (Griffiths 2007).

CONCLUSION

The aims and methodologies of science museums have evolved substantially since their origins in the 1800s. But only fairly recently has the discipline of museum studies begun assessing the response of visitors to exhibits and scientifically advancing the goal of public education and outreach. In the 1970s science museum visitor studies arose largely in response to the requirements of the National Science Foundation, the major source of federal support for science-technology center exhibitions and programs in the US (Friedman 2010).

Of course, the scientific method should not be limited to the laboratory. The efforts of museums to communicate mankind's scientific legacy should also – like experiments themselves – be subject to repeatable, evidence-based studies. It is very encouraging that the Smithsonian is applying this outlook to the development of exhibits and the engagement of a new generation of visitors.

The concepts associated with IPOP are far-sighted and have important implications for filmmakers and exhibit designers. At this time the IPOP approach has been studied in over 4,000 individual visitor surveys and is considered in its “mid-stage evolutionary process” (Pekarik 2014). An original category *Reflective* has been eliminated and the new one *Physical* has been added, and verified with sophisticated mathematical analysis (Schreiber et al. 2013). The paradigm helps point the way to integrating our most current understanding of educational pedagogy with psychology for the purpose of advancing science. It is very refreshing to see the breadth of thinkers addressed rather than the “majority” or the “underserved.” Approaching visitor satisfaction in this scientific manner is entirely consistent with the Smithsonian Institution's mission to “increase the diffusion of knowledge”.

Video has an unequalled ability to transport a viewer's imagination and reach people on an emotional level. By bringing IPOP typologies into the video exhibit production process, we can more accurately assess and address visitor satisfaction. Of course, IPOP is not a panacea; it cannot tell a filmmaker how to create a successful and highly watched exhibit video. While a visitor's choice to watch a film depends on her /his initial interest, the story and craft of the video can either captivate the viewer or

lose their attention. Nevertheless, informing content choices with an IPOP perspective is an insightful approach, supported by the data.

Therefore, based on my analysis and my work at the Smithsonian, I believe future video exhibits for science museums should implement several actionable concepts:

- There should be a balance of content between *Ideas*, *People*, *Objects* and *Physical* in order to appeal to the broadest numbers of viewers. This approach should facilitate “flip” and result in greater learning and sense of achievement by visitors.
- In a collections-based institution like the Smithsonian, the *Ideas* approach to video production should be strengthened. Offering video and exhibit content on big ideas may require larger exhibits and more funding. However, presenting abstract ideas in a creative way is crucial to engage certain audiences and present diverse conceptions.
- Particularly important — and surprising lacking at present — is video material providing *People*-oriented experiences. More personal portraits of scientists and their work will increase “affective learning” and can assist in creating an emotional link between the personalities and struggles of scientists as depicted on-screen and the visitor. Other social needs of museumgoers should be taken into consideration as well. The use of theater spaces for group video consumption is very important and should be inviting, easily seen and accessible but intimate.
- Offering video choice and interactivity can bring on board physical learners. Augmented reality has tremendous possibilities for tethering objects to *Physical* selection. When video productions are longer than 2-3 minutes, they should be broken up with an interactive element (unified with the *Physical*). The architectural design of the exhibit and physical installations of videos should help convey the central message while avoiding redundancy.

It is my hope that more museums embrace IPOP and continue to develop an increasingly scientific approach to visitor studies and science education. This work is vital to strengthen the bond between museums, science in the public interest and the world’s populations.

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